Pion and Kaon Production in central Pb+Pb Collisions at 40 GeV per Nucleon from the NA49 Experiment[G,B]

A.Billmeier[1], C.Blume[2], R.Bramm[1], P.Buncic[1], P.Dinkelaker[1], M.Gaździcki[1], T.Kollegger[1], I.Kraus[1], C.Markert[2], A.Mischke[2], R.Renfordt[1], A.Sandoval[2], H.Sann[2], R.Stock[1], H.Ströbele[1], M.Wensveen[2], A.Wetzler[1], J.Zaranek[1] for the NA49 Collaboration.
[1]Universität Frankfurt, [2]GSI Darmstadt

The creation of new particles is the most important process in high energy nuclear collisions and its excitation function may allow to detect threshold effects and non-monotonic behavior. The NA49 experiment at the CERN SPS has complemented its 158 GeV per nucleon data by recording 1.8 million Pb+Pb events at 40 GeV per nucleon in fall 1999 and 400.000 central events at 80 GeV per nucleon in fall 2000. Results on pion and kaon production in central (7%) 40 GeV per nucleon events are presented here.

The experiment NA49 was designed for Pb-beams at top SPS energy. The effects of a four times lower Lorentz boost at 40 GeV/nucleon was compensated by lowering the magnetic field strength accordingly. This kept all the essential features of the NA49 detector [1] intact. The identification procedures based on the specific enery loss (dE/dx) were supplemented by time-of-flight identified particles in the TOF acceptance regions. In order to get pion rapidity spectra, one had to identify pions in momentum intervals where their energy loss is the same as for kaons or protons. Therefore we first analysed negatively charged particles [2]. To get the π^- spectrum, we subtracted the kaons and antiprotons as identified by dE/dx (at different laboratory momenta!) and then constructed from the resulting π^- the π^+ spectra using dE/dx determined π^+ to π^- ratios in regions where identification was possible. Those parts of the spectra for which the ratios were not measured have been obtained from extrapolation.

Acceptance losses, tracking inefficiencies and losses due to particle identification procedures were corrected for in bins of rapidity and p_T. The systematic errors on the multiplicity of pions and kaons are estimated to be less then 10%. Since the NA49 acceptance covers only the forward hemisphere, the measured spectra were mirrored at midrapidity to calculate the total multiplicities.

Fig.1 shows the rapidity distribution of negatively charged pions. The rapidity density at mid-rapidity is 110 $\pm$ 5 and the FWHM of the distribution comes out to be 2.45 $\pm$ 0.1. This is to be compared to 3.4 $\pm$ 0.15 at 158 GeV per nucleon. The respective fractions relativ to the full rapidity gap are very similar. The integral over the full rapidity distribution yields an average of 313 $\pm$ 15 π^- per central event. Fig.2 displays the transverse mass distribution of the pions. Its form is obviously not an exponential. We therefore refrain from giving a slope parameter but rather calucte the mean $p_T = 0.36 \pm 0.2$, which is slighly lower than the value found at 158 GeV per nucleon.

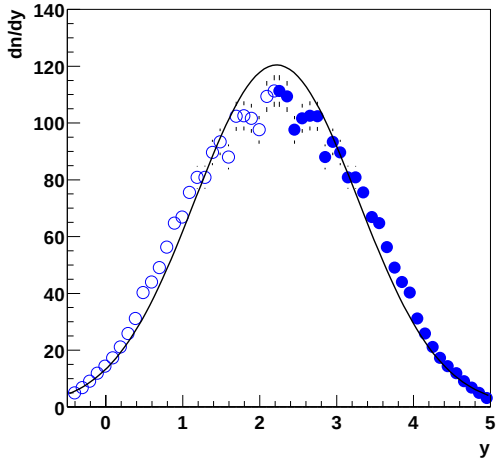

Figure 1: Rapidity distribution of negatively charged pions in central Pb+Pb collisions at 40 GeV per nucleon.

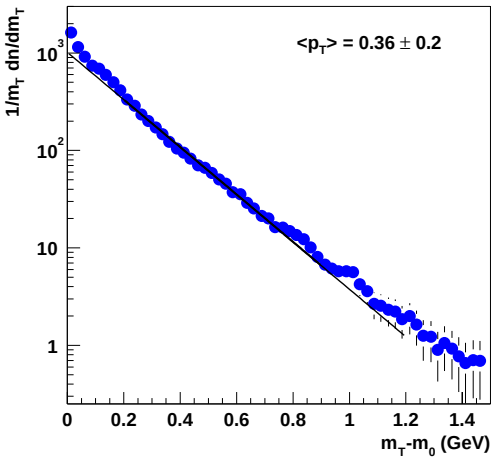

Figure 2: Transverse mass distribution of negatively charged pions in central Pb+Pb collisions at 40 GeV per nucleon.

In Fig.3 we present the rapidity distributions of charged kaons. The integrals over the full rapidity distributions yield 17.8 $\pm$ 0.9 K^- and 56.3 $\pm$ 3 K^+ per central event [3]. The total yields and the multiplicities at midrapidity are summarized in table 1.

	total yield	midrapidity yield
π^-	313 ± 15	110 ± 5
π^+	282 ± 15	99 ± 7
K^-	17.8 ± 0.9	8.18 ± 0.4
K^+	56.3 ± 3	20.52 ± 1

Table 1: Pion and kaon multiplicities in central 40 A·GeV Pb+Pb collisions, the midrapidity yields are calculated for $|\frac{y-y_{cm}}{y_{cm}}| < 0.125$.

These measurements allow together with previous NA49 measurements at 158 GeV per nucleon [4], measurements at the AGS [5] and RHIC [6] to plot the energy dependence of the $K^+/\pi+$-ratio. It shows a non monotonic behavior in the SPS energy range (figure 4). To further study this structure, the 80 GeV per nucleon data is currently being analysed and NA49 will take additional Pb+Pb data at 20 and 30 GeV per nucleon.

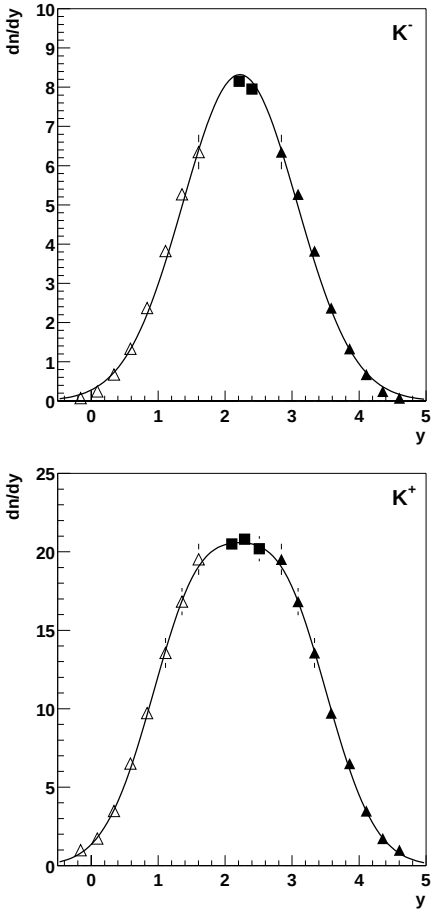

Figure 3: Rapidity distribution of charged kaons in central Pb+Pb collisions at 40 GeV per nucleon. Squares are from TOF-dE/dx analysis, triangels from dE/dx-only analysis. Open symbols are reflected at midrapidity.

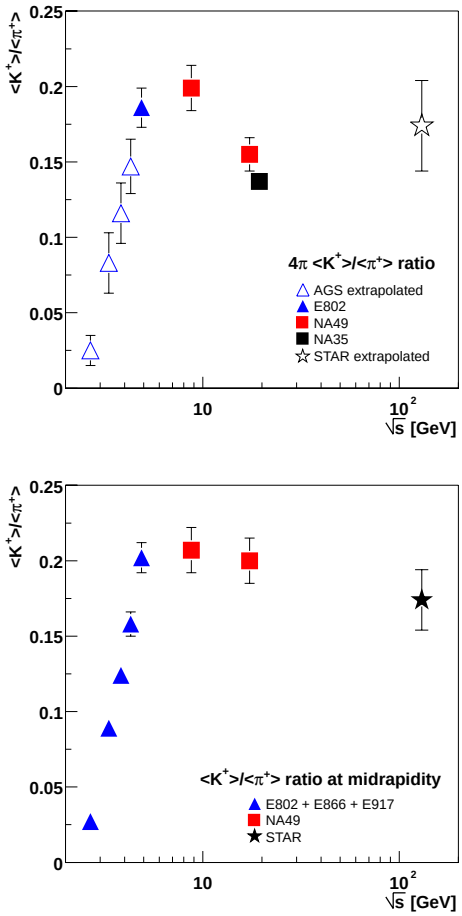

Figure 4: $K^+/\pi+$-ratio as function of collision energy for central Au+Au and Pb+Pb collisions. Figure a) shows the 4π-ratios, b) the midrapidity ratios

References

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